Modular Assays for Solar System Exploration

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With the advent of a new era of Astrobiology missions to search our solar system for evidence of life we would like to update the community on the use of protein microarrays for detection of viable and fossil life biomarkers on Mars. We successfully proposed this instrument in 1999 to NASA and ESA for the now defunct 2005 mission (under the title MILDI) and have recently received NASA ASTID funding. Science and engineering definition have been ongoing since 1999, culminating in system designs and breadboards that are now being tested under ASTID funding.

It is imperative that if biotechnology techniques such as protein microarrays or other similar types of instruments be used for life detection on Mars that proof of concept science to show the compatibility of the probes (i.e. antibodies), fluorophores, reagents, reactions and microfluidic chips for space flight and Martian environments. In summary over the last two years the MASSE project has:

- Developed an initial custom protein array for the detection of viable life marker molecules. This chip has been tested using several extraction methods and using spiked Martian regolith.
- Developed a fossil antigen marker chip that has successfully detected antigenic activity in samples up to 65 million years old.
- Developed and tested antihopane antibodies for fossil life detection. This work is ongoing.
- Verified the antibody binding reaction kinetics in Martian and 0 G testing.
- Tested 25 separate extraction protocols for use in a microarray microfluidic device.
- Demonstrated gram negative, positive and archaeal cell lysis in microfluidic channels.
- Built and are currently testing a prototype extraction device for use with simulated Martian regolith.
- Demonstrated the use of the Limulus Amoebocyte Lyase test as a verification test for bacterial detection by protein microarrays and indeed shown how the enzymes involved may be used in a microarray format.
- Designed microfluidic systems for all the steps to prepare a sample for inoculation onto a microarray.
- Built a breadboard optical detection system and a design for a miniaturized unit.
- Currently undertaking radiation exposure experiments for fluorophores and microarrays and have tested the longevity of microarrays for use in a Mars instrument.

We will present a cross section of these results and show how we have field tested the protocols for microarray analysis and show how the science definition studies outlined above will aid in instrument definition and development for the ESA Exomars opportunity.